

# A DC Transformer

Completed Technology Project (2012 - 2013)



## Project Introduction

The goal of the project was to demonstrate a true direct current (DC) transformer, a new electro-mechanical component with potentially high power applications; in other words, an elementary device that could convert DC voltage/current directly to a different DC voltage/current. Alternating current (AC) transformers achieve this conversion for AC voltages/currents through the use of coils, ferrous cores, and an application of the Faraday Induction Law, where time varying magnetic fields are created by and then create alternating voltages in a coil.

During the period of this project three different possible DC transformer concepts were proposed, theoretically modeled, and then experimentally tested with the intent of demonstrating a true dc transformer; i.e. an electrical device into which a given DC voltage and current can be applied and which will generate a different voltage and current, effectively changing the impedance of a power supply.

A component level DC transformer is described in which no alternating currents or voltages are present. It operates by combining features of a homopolar motor and a homopolar generator, both DC devices, such that the output voltage of a DC power supply can be stepped up (or down) with a corresponding step down (or up) in current.

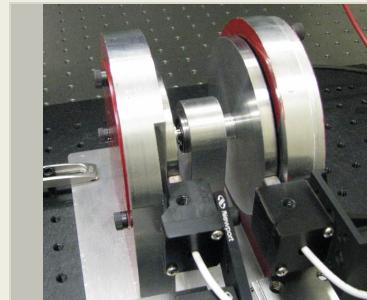
Based on demonstrated technology, this DC transformer should be scalable to low megawatt levels, but it is more suited to high current than high voltage applications. Significant development would be required before it could achieve the kilovolt levels needed for DC power transmission.

## Anticipated Benefits

NASA's return on investment for this project is a revolutionary advance. No DC transformer has ever been demonstrated, so this will not only yield a new device and new capability, but will highlight NASA's innovation capability and lead to new insights within electro-magnetism.

The proposed work develops a true DC transformer that can be scaled up to very high power levels. DC to DC converters exists, but these are low power devices consisting of semiconductor switches.

This device may become a commercially available entity, not unlike AC transformers are now. A manuscript was published in the January 2014 issue of IEEE Transactions on Power Electronics, titled "A DC Transformer" (VOL. 29, NO. 1); the letter presents an electromechanical component that transforms dc power, allowing DC voltages or currents to be stepped up or down.



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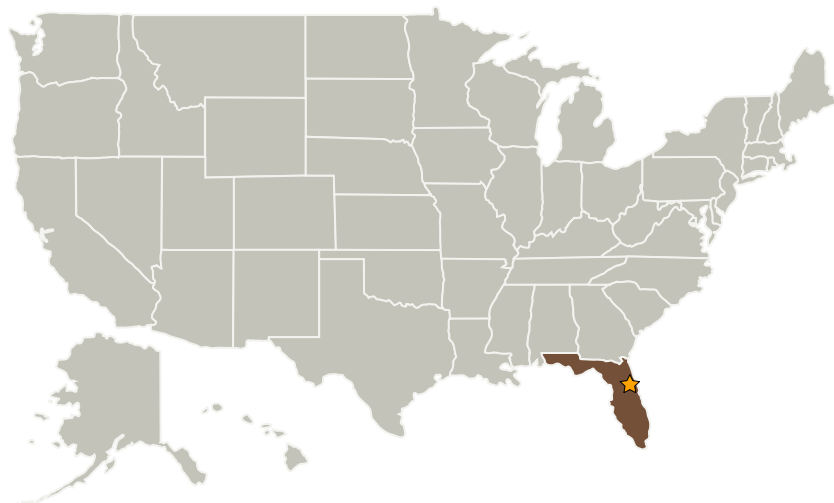
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## Primary U.S. Work Locations and Key Partners



| Organizations Performing Work       | Role                    | Type          | Location                      |
|-------------------------------------|-------------------------|---------------|-------------------------------|
| ★ Kennedy Space Center(KSC)         | Lead Organization       | NASA Center   | Kennedy Space Center, Florida |
| Air Force Research Laboratory(AFRL) | Supporting Organization | US Government | Notre Dame, Indiana           |

## Primary U.S. Work Locations

Florida

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Kennedy Space Center (KSC)

**Responsible Program:**

Center Innovation Fund: KSC CIF

## Project Management

**Program Director:**

Michael R Lapointe

**Program Manager:**

Barbara L Brown

**Project Manager:**

Nancy P Zeitlin

**Principal Investigator:**

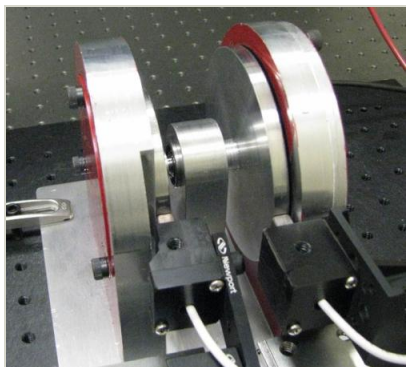
Robert C Youngquist

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### Images



**A small scale device was constructed to demonstrate the dc-dc transformer concept using a pair of conducting disks.**

A DC Transformer  
(<https://techport.nasa.gov/image/2123>)

### Stories

A DC Transformer; IEEE Transactions on Power Electronics manuscript  
(<https://techport.nasa.gov/file/1196>)

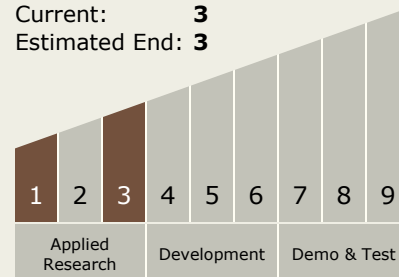
### Links

Provisional Patent: A DC Transformer  
(no url provided)

A DC Transformer  
(no url provided)

### Technology Maturity (TRL)

Start: **1**  
Current: **3**  
Estimated End: **3**



### Technology Areas

#### Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.3 Power Management and Distribution
    - TX03.3.3 Electrical Power Conversion and Regulation